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Sound-reproducing transducer

The present invention relates to a sound-reproducing transducer connected to a printed circuit, and to a terminal comprising this kind of transducer.

One non-exclusive field of application of the invention is that of mobile radiocommunication terminals.

Manufacturers of mobile communication terminals are currently seeking to miniaturize them as much as possible whilst preserving optimum functional ergonomics.

This optimization of the size of the terminals, of which figure 1 is a diagrammatic side view, has impelled manufacturers to reduce their thickness.

A mobile terminal comprises a casing 10 in which are disposed various components such as a battery 20, a keypad 30, a screen 40 and a sound-reproducing transducer 60 connected to a printed circuit 50.

The sound-reproducing transducer or sound transducer 60 is adapted to transform electrical signals supplied to it into sound waves and vice-versa.

The sound transducer 60 may fulfill a plurality of functions such as those of earpiece, loudspeaker, ringer and vibrator.

The earpiece is essentially intended to be placed against the ear of a user when using the device to communicate, the ringer is used to alert the user to an incoming call or any other action, the loudspeaker enables sound reproduction at high volume for hands-free or ringer applications, for example, and the vibrator is used to alert the user discreetly to an incoming call through vibration of the earpiece.

To reproduce the sound waves, the sound transducer 60 consists of two distinct volumes defining a front acoustic cavity 61 and a rear acoustic cavity 62 the shapes and dimensions whereof must be adapted to allow sound reproduction of sufficient quality for the application for which the transducer is intended.

This sound reproduction is obtained by virtue of vibrations of a diaphragm that will be precisely defined hereinafter in the description of figure 3.

Moreover, the earpiece function necessitates a smaller component size than that required for a loudspeaker and ringer function which must emit sound at a greater volume. The volume occupied by the sound transducer 60 may not therefore be reduced beyond a certain limit imposed by the loudspeaker function.

Now, the current trend is to reduce the size and in particular the thickness of terminals.

Accordingly, the rear acoustic cavity 62 of the sound transducer 60 of current terminals has a volume of insufficient size and the space between the rear face of the transducer and the printed circuit is too small to allow sound reproduction of sufficient quality.

Inopportune damping of vibrations in the diaphragm of the sound transducer 60 occurs if the space between the rear face of the transducer and the printed circuit is less than 1 mm thick.

Those vibrations generating the sound, this leads to insufficient quality of sound reproduction.

An object of the invention is to propose a sound transducer having sound reproduction of satisfactory quality even though its rear face is very close to another component of the terminal.

To this end, the invention provides a sound-reproducing transducer connected to a printed circuit, the transducer having the shape of a hollow cylinder whose cylindrical wall delimits two circular faces: a front face and a rear face that are opposed and planar,

the transducer comprising at least one diaphragm for converting electrical signals into sound waves and vice-versa,

the diaphragm being a circular membrane parallel to the front face and the rear face of the transducer,

the diaphragm delimiting two distinct volumes in

the transducer:

- the first volume, bordered on one side by the circular face of the transducer and on the other side by the diaphragm, this first volume forming a front acoustic cavity, and
- the second volume, bordered on one side by the circular face of the transducer and on the other side by the diaphragm, this second volume forming a rear acoustic cavity,

characterized in that said cylindrical wall of the transducer includes at least one perforation.

The invention therefore facilitates the flow of air to the rear of the sound transducer and thereby enables acoustically satisfactory use of the transducer.

In one particular embodiment, the perforation forms a hole in the rear acoustic cavity of the transducer.

In one particular embodiment, said circular face of the transducer has at least one perforation.

Another aspect of the invention also provides a radiocommunication terminal comprising a sound-reproducing transducer as just defined.

Other features and advantages of the invention will become apparent on reading the following description of one particular embodiment of the invention, which is given by way of illustrative and nonlimiting example, and examining the appended drawings.

Figure 1, already described, is a diagrammatic view in cross section of a radio communication terminal showing its main components.

Figure 2 is an exploded three-dimensional view of the sound transducer of the invention included between the printed circuit and the casing of the terminal.

Figure 3 shows a sound transducer in longitudinal section taken along the line I-I in figure 2.

In the remainder of the description, the invention is described in its application to radiotelephones or mobile telephones.

It applies more generally to all types of radio transceivers, for example a radio pager, a personal digital assistant (PDA) or a laptop computer.

Referring to figure 2, the general shape of the transducer 60 is that of a hollow cylinder the exterior cylindrical wall 66 whereof is delimited by two opposite circular faces: a front face 66c and a rear face 66d, both of which are substantially plane.

These faces 66c, 66d are substantially parallel to each other.

The front circular face 66c constitutes the front face 63a of the transducer 60. The rear circular face 66d constitutes the rear face 63b of the transducer 60.

The diaphragm 64 of the transducer 60, which is defined more precisely hereinafter, is situated between the front circular face 66c and the rear circular face 66d and is substantially parallel to them, at approximately half the height of the exterior wall of the transducer 60.

To enable the transducer 60 to function, its diaphragm 64 must be able to vibrate, and so air must be able to circulate between the transducer 60 and the casing 10 of the terminal.

To this end, the rear acoustic cavity 62 defined between the rear circular face 66d and the diaphragm 64 usually has perforations 70a, 70b, 70c situated on the rear face 66d.

These perforations 70a, 70b, 70c may be of diverse shapes and sizes.

For example, a substantially round perforation 70b is situated at the center of the rear circular face 66d and its radius is approximately one third of the radius of the rear circular face 66d.

Substantially round perforations 70a and 70c are situated toward the periphery of the circular face 66d and their radius is approximately one tenth of the radius of the circular face 66d.

Accordingly, air can escape through these

perforations to the rear of the transducer 60.

However, because of terminal miniaturization constraints, the sound transducer has a rear acoustic cavity 62 of very small volume and the rear circular face 66d of the transducer is located too close to the front face 51 of the printed circuit 50.

The transducer 60 of the invention has an apertured cylindrical wall 69a, 69b.

Thus the cylindrical wall 69a, 69b of the transducer 60 comprises perforations 72, 74, 76, 77, 78.

The presence of these perforations 72, 74, 76, 77, 78 increases the flow of air at the exit from the transducer 60 and encourages effective circulation of the sound waves.

In one particular embodiment, the perforations 72, 74, 76, 77, 78 are of substantially rectangular shape.

Their size is approximately one third of the height of the cylindrical wall 69a, 69b.

The substantially rectangular perforations 72, 74, 76, 77, 78 are situated close to the junction between the cylindrical wall 66 and the front circular face 66c, at a distance of approximately one twentieth of the height of the cylindrical wall 66 from the front circular face 66c.

These rectangular perforations 72, 74, 76, 77, 78 situated close to the junction between the cylindrical wall 66 and the front circular face 66c increase the efficiency of the transducer 60 by approximately 50% compared to a transducer that does not have these perforations.

Referring to figure 3, a transducer 60 conventionally includes a diaphragm 64 delimiting two cavities in the transducer 60: a front cavity 61 and a rear cavity 62, a coil 67, a magnet 68, and a metal support 69, such as a yoke, comprising a magnetic circuit 69a and a weight 69b.

The coil 67, the magnet 68 and the metal support 69 are situated in the front cavity 61 and therefore between the diaphragm 64 and the front circular face 66c of the

transducer 60.

The transducer 60 consists of two portions, an electrically neutral first portion including the diaphragm 64 and the cylindrical wall 66, which are made from dielectric materials such as plastics materials, for example, and an electrically conductive second portion including the coil 67, the magnet 68 and the metal support 69, which are made of conductive materials.

The front acoustic cavity 7 is bordered on one side by the front circular face 66c of the transducer 60 and on the other side by the diaphragm 64.

The rear acoustic cavity 62 is bordered on one side by the rear circular face 66d of the transducer 60 and on the other side by the diaphragm 64.

The diaphragm 64 is a substantially circular membrane parallel to the front and rear circular faces 66c and 66d.

The diaphragm 64 is fixed to the inside face of the cylindrical wall 66 along the whole of its perimeter.

The diaphragm 64 is fixed to the coil 67 along the whole of the inside perimeter of the coil 67.

The diaphragm 64 has its center substantially in the middle of the generatrix of the transducer 60.

The coil 67 is substantially the shape of a hollow cylinder composed of two substantially circular disks and a cylindrical wall. This is known in the art.

Its generatrix is situated on the generatrix of the cylindrical transducer 60 and its center substantially in the middle of the generatrix of the transducer 60.

Its disks are substantially parallel to the circular faces 66c and 66d.

Its radius is approximately half the radius of one of the circular faces 66c or 66d.

The coil 67 is fixed to the magnetic circuit 69a along the whole of the perimeter of one of its disks and the other disk is fixed to the diaphragm 64.

The magnet 68 is substantially in the shape of a

solid cylinder. This is known in the art.

Its circular faces are substantially parallel to the circular faces 66c or 66d.

Its generatrix is situated on the generatrix of the cylindrical transducer 60 and its center is substantially in the middle of the generatrix of the transducer 60.

Its radius is slightly less than the radius of the coil 67.

One of the circular faces of the magnet 68 is fixed to the magnetic circuit 69a.

The magnet 68 and the coil 67 are recessed into the magnetic circuit 69a.

The magnetic circuit 69a has the general shape of a hollow cylinder with a wide rim made up of a substantially circular face and a ring parallel to the circular face and a thick cylindrical wall. All this is known in the art.

Its circular face and its ring are substantially parallel to the circular faces 66c and 66d of the transducer 60.

Its generatrix is situated on the generatrix of the cylindrical transducer 60 and its center is substantially in the middle of the generatrix of the transducer 60.

Its radius is slightly greater than that of the coil 67.

The weight 69b is of substantially the same shape as the magnetic circuit 69a and the magnetic circuit 69 is recessed into the weight 69b. This is known in the art.

Its radius is slightly greater than that of the magnetic circuit 69a.

Its cylindrical wall is fixed by suspension members 65 to the cylindrical wall 66 of the transducer 60.

The suspension members 65 are fixed, firstly, to the middle of the cylindrical wall of the metal support 69 and perpendicularly to the latter and, secondly, perpendicularly to the external face of the cylindrical wall 66 of the transducer 60. All this is known in the art.

The suspension members 65 are springs, for example,

extending parallel to the circular faces 66c and 66d of the transducer 60.

The suspension members 65 connected to the weight 69b form a suspension-weight system that is caused to vibrate when the coil 67 is excited by an electrical current.

The invention therefore enables acoustically satisfactory use of the transducer 60 under critical conditions in respect of the space between the various components of the radiocommunication terminal.